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Removable orthodontic appliances: new perspectives on capabilities and efficiency

ABSTRACT

Aim Removable appliances are a dependable choice for many patients but like all orthodontic appliances, they have some limitations in use. Patient selection and appropriate appliance design are two key factors for success. Many patients, especially adults, prefer intra-oral appliances to extra-oral devices. Sometimes a removable intra-oral appliance can solve a dental problem in a shorter period of time compared to fixed treatment, and this has also been repeatedly seen in molar distalisation. From the interceptive perspective, the appliance can prevent or alleviate an impending crowding for erupting permanent incisors.

Case Report This article describes 5 patients with different orthodontic problems: impending crowding for erupting upper canine with 2 approaches, provision of space for upper cuspsids, resolution of chronic attrition of anterior teeth, relief of space shortage for upper canines eruption, and reduction of excess overjet. All subjects were treated with removable appliances of various designs.

Keywords Aesthetics; Clasp; Finger spring; Intra-oral and extra-oral appliances; Removable appliances; Tooth tipping.

Introduction

Removable appliances have the longest history in orthodontic literature and practice. In early 1900, a removable appliance was pioneered by George Crozat in the US [Proffit et al., 2007], however the device was further developed and integrated into many diverse treatment modalities in Europe. Unfortunately, in recent decades, intra-oral removable appliances are less discussed in the orthodontic literature and fewer researchers tend to investigate their indications and advantages.

With the innovation of fixed appliances, the removable appliances for tooth movement were gradually less used. However, there are many conditions in which these would be the appliances of choice for tooth movement, especially if early intervention is required and a fixed appliance for any reason is not indicated. Removable appliances have advantages and disadvantages [Proffit et al., 2007]: They are affordable for patients, financially, and easy adjustable for orthodontists, technically.

Visibility of extra-oral appliances, is socially unacceptable to adults and even to most children. While the use of removable appliances presents obvious advantages for socially active people, the success of treatment can be very patient-dependent. Although skeletal anchorage (mini-implant system) is a novel alternative in selected cases and is becoming a more dependable approach for tooth movement, it is not applicable for all patients and has also some restrictions in use [Chung et al., 2010].

In selected cases, however, treatment with fixed appliance may be shortened by a previous treatment with a removable appliance. The latter is a good choice if oral hygiene with fixed appliance is unmanageable, especially in uncooperative youngsters. Often intra-oral appliances are an ideal choice for some patients, particularly adults. For a child or adolescent, if an extra-oral gadget is intolerable and repeatedly broken, an intra-oral appliance is usually well accepted (Fig. 1).

It should be kept in mind that all removable appliances of any kind, are only capable of “tooth tipping” [Satley

FIG. 1 A repeating problem by noncompliant patients.
A. A broken and distorted band.
B. A distorted and frequently broken headgear.
et al., 2001; Proffit et al., 2007), meaning that after repositioning the long axis of the tooth should become ideal in angulation and torque. Thus, a selected case for removable appliance requires the long axis of the tooth be so malpositioned that after movement the tooth can be located in the proper crown-root torque. This biomechanics concept dictates the orthodontist to be very accurate in case selection. Thus, the removable technique is not considered as an alternative method if a patient needs comprehensive orthodontic care.

Technically, appliance design has a key role in success. The location and type of clasps (for better retention and no tissue irritation), the location of finger springs (for maximum range of activation) and their direction (for highest rate of activation) are important considerations in the design of an appliance.

Scientifically, some clasps which are routinely included in all appliances do not have any designated purpose. It should be really reevaluated whether an Adams clasp with its tough adjustment, which provides only a little retention and creates serious occlusal interference, causing patient’s discomfort, should be preferred over a "C" clasp. The design of the "C" clasp creates a contact surface with the anchor tooth rather than a two-point contact (Adams clasp), resulting in better retention. In addition, it offers the advantages of causing less tissue irritation along with easier adjustability and fabrication. Finally, a small and easy to adjust ball clasp in many cases can play a significant role in retention of the appliance. The other consideration is the type of active part used in the appliance. Clearly, its tough adjustment, which provides only a little retention and creates serious occlusal interference, causing patient’s discomfort, should be preferred over a "C" clasp. The design of the "C" clasp creates a contact surface with the anchor tooth rather than a two-point contact (Adams clasp), resulting in better retention. In addition, it offers the advantages of causing less tissue irritation along with easier adjustability and fabrication. Finally, a small and easy to adjust ball clasp in many cases can play a significant role in retention of the appliance. The other consideration is the type of active part used in the appliance.

Material and methods

Five cases with different problems and various appliance designs are presented in this article. Two cases needed molar distalisation due to reduced space for the erupting upper cuspid teeth: one case was treated with an appliance provided of a spring to push both first and second upper molars (case 1) and the other with an appliance provided of two springs for each molar (case 2). In one case, the treatment plan aimed at closing the anterior diastema to provide space for the rotated erupting upper laterals (Case 3). Case 4 had an anterior crossbite which was treated with lingual tipping of the lower incisors. The fifth and last case aimed to treat protruded upper anterior teeth.

Case 1
FB was a 14-year-old girl who preferred a removable intra-oral appliance. Therefore, the appliance was proposed to resolve the position of the buccally erupting upper right canine. This was accomplished with a removable appliance which would distalise the upper right first molar to gradually provide a space for the canine. Transeptal fibres between teeth provided a gradual distal tilt to the second and subsequently the first premolars after molar distal relocation. Treatment started in June 2009 and activation ended in September Sept 2009, a 3-month period. The appliance continued to be worn for additional 5 months (March 2010) as retainer (Fig 2).

Case 2
MAT was a 13-year-old boy who did not wear his headgear as instructed. Thus, after 6 months he was delivered a removable appliance for application of unilateral distalisation of the upper left first and second molars. Fortunately, this time he was compliant with the new method. The appliance was equipped with 2 finger springs to distalise both upper left molars at the same time. The labial bow was placed between the upper right canine and the upper left lateral incisor to allow the canine to erupt freely in the proper position. A ball clasp on the upper right molar also retained the appliance in place. Interestingly, the treatment concluded after only 5 months. The appliance was used as retainer for an additional time until full eruption of the upper left canine (Fig 3).

Case 3
HER was a 9-year-old boy whose mother was concerned about the eruption of both upper laterals in a tight space. An appliance was fabricated with two finger springs distally to the upper central incisors to close the diastema. This process took 4 months but the retention period added other 7 months for full eruption of the upper lateral incisors. It appeared there was a reasonable maxillary anterior lateral growth potential during the treatment to compensate for the additional space for incisor laterals.
FIG. 2 Pt. FB (case 1).
A: Occlusal view: UR3 is erupting in an insufficient space.
B: Right lateral view: The semi-erupted position of the canine.
C: A removable appliance is fabricated with 2 ball clasps, a labial bow and a simple finger spring to be placed between second premolar and first molar. Note that the labial bow is, rather, extended from UR2 to UL3 to permit distal drifting of canine and premolars.
D: The appliance is being checked for easy fitting; and the patient was instructed for properly wearing.
E: Space provision after 3 month visits as the result of molar distalization. Note that transeptal fibers facilitate distal drifting of the canine and premolars with no further intervention.
F: The clinical stability of the results after 4 months out of treatment.

Thus, the appliance was a perfect facilitator for growth potential to allow alignment of the laterals. This process exactly occurs at this stage of dentition or between the ages of 8 and 9 (Fig. 4) [Pinkham, 2010].

Case 4
PJ was a 42-year-old female who sought orthodontic treatment for lower anterior crowding resulting in severe incisal attrition due to zero overjet. She was concerned about the length of treatment. She also exhibited crowding of the lower and upper arch. A combination plan of orthodontic treatment and restorative procedures was tailored for her. A removable appliance, rather than a fixed treatment, was delivered to the patient to resolve the lower anterior crowding, moving the lower central incisors lingually and the lateral incisors slightly labially. The adjunct procedure was reproximation of the central incisors. Finally, the patient underwent aesthetic restoration of the upper and lower incisors, and the case was finished with an acceptable aesthetic smile and normal overjet and overbite (Fig. 5).

Case 5
KO was a 14-year-old girl complaining of prominent upper anterior teeth and, as all youngsters with excessive overjet, she was due to excess overjet. In these cases a Hawley retainer with circumferential wire for maxillary arch with gradual tightening loops could reduce the overjet. The acrylic resin was selectively reduced on the palatal side of the anterior teeth. A space maintainer was used for the lower arch. It took around 7 months to achieve an acceptable result. Stability of the treatment after one year was evident (Fig 6).

Discussion
In this case series, selected from a large group of successful cases, removable appliances with different designs were used to test the suitability of this technique.
FIG. 3 Pt. MAT (case 2).
A: UL3 has no enough space to erupt; however, a right treatment plan and a timely intervention can prevent later malposition of canine.
B: A removable appliance fabricated with a "c" and a ball clasp, plus a labial bow. Two finger springs is designated to distalize second and first molars in ULQ. Again, the labial bow is wrapped at the distal of UL2, not to interfere with canine eruption and its distal drifting. Note that no clasp was placed on premolars for freely distal drifting.
C: The appliance is viewed in mouth from the left lateral view.
D: Space is opened (overcorrection) in ULQ after 5 months and the appliance is continued to be worn for retention till full alignment of cuspids and bicusps.

FIG. 4 Pt. HER (case 3) in mixed dentition.
A: UL2 & UR2 have no enough space to erupt; a little space exists between upper centrals. An early intervention can prevent later malposition of laterals.
B: A removable appliance was ordered with four "c" clasps on UD’s and UE’s for full retention, and 2 finger springs are designed to move the U1’s toward midline. Note, no labial bow included in the appliance. For comfort of patient, the acrylic plate was only extended to distal of primary second molars.
C, D: 7 months later, the goals of treatment was achieved and maintained for a few extra month. The laterals are in perfect alignment and the adjacent teeth are not malposed.
FIG. 5 Pj is an adult patient (case 4).
A: Frontal view shows severe attrition due to long-term edge-to-edge incisor relationship with a very unpleasant smile.
B: Mandibular occlusal view indicates anterior crowding with labial displacement of centrals and lingual displacement of laterals.
C: Maxillary occlusal view depicts rotational displacement of centrals.
D: A removable appliance is fabricated with 4 "ball" clasps, and a labial bow is designed to force centrals lingually and to retain the appliance, as well. A lingual bow is included to push laterals labially, simultaneously. Two occlusal rest on 6’s hold the appliance vertically.
E: The appliance is delivered to patient with no discomfort in place.
F: A neat reproximation was performed on mesial of centrals, followed by fluoride application. The labial bow was activated using 3-prong pliers along the labial surface of centrals, while the lingual bow gently pushes laterals forward.
G: After the final restorative consult, the orthodontic treatment was finished and patient was referred for restorative procedures.
H: The patient’s smile 8 months after treatment.

Many children and definitely adults, if they are to wear an appliance, would prefer a less visible one. If the patient is compliant, the speech disturbances will resolve in a short period of time. Tongue usually will adapt with the newly defined intra-oral space.

Although one finger spring is capable of exerting enough force to move even two molar teeth at the same time, it is not unjustifiable if one decides to move the molars sequentially (Case 1). Four factors should be considered when employing springs: First, location and second direction of the spring loop are both important for efficient tooth movement. The finger spring should be located on the midway of the mesiodistal aspect of the molar, while the loop on the opposite direction of movement. Third, to permit passive distal drifting of canines and premolars no clasp should placed on the named teeth. Forth, interdental acrylic extension between canines and premolar of the appliance should be removed.
Maxillary canines are the last teeth to erupt in the upper jaw, and therefore they often face space shortage, resulting in impaction which requires additional treatment procedures with multiple considerations [Zafarmand et al., 2009]. The growth potential may also play a significant role in the success of treatment. A removable appliance can facilitate eruption of the canine in the right position. The attempt to reproximate the primary canines would be absolutely unjustified. Although the result can be the alignment of lateral ones, this happens at the cost of the loss of arch circumference.

Concerning the retention phase, in some cases the same appliance can be used for this purpose for a defined period of time. In recent years, the clear full coverage retainer, namely “Essix”, has been demanded by many patient, especially socially active adults [Sheridan et al., 1993]. This type of appliance is much less visible and easy to use. Lastly, it is important to underscore that clinical practice is a balance of experience and intuitive clinical experimentation of the practitioner in any clinical decision, an evolving process that shapes our philosophy of treatment.

Conclusion

Intra-oral removable appliances are the appliance of choice for many youngster and definitely adult patients. Less compliant patients are more prone to wear such hidden appliances. Moreover, the finger springs of these appliances are more effective than than devices of complicated design and provided with screws. Cost-wise, the appliance is the best choice for patients. Another advantage is represented by less oral hygiene complications. Finally, the device is simple to adjust for the orthodontist, and the easy management of the appliance by the patient ranks it as a very dependable treatment option in orthodontics.

References